John von Neumann (1903-1957)

On the occasion of his 110 Anniversary

John von Neumann: Past and Present

Balint Domolki

Dr. Domolki participated in the building of the first electronic computer in Hungary, held several leading positions in the software industry and represented Hungary in various IFIP bodies. He is Honorary Chairman of the John von Neumann Computer Society and its representative to IT STAR.

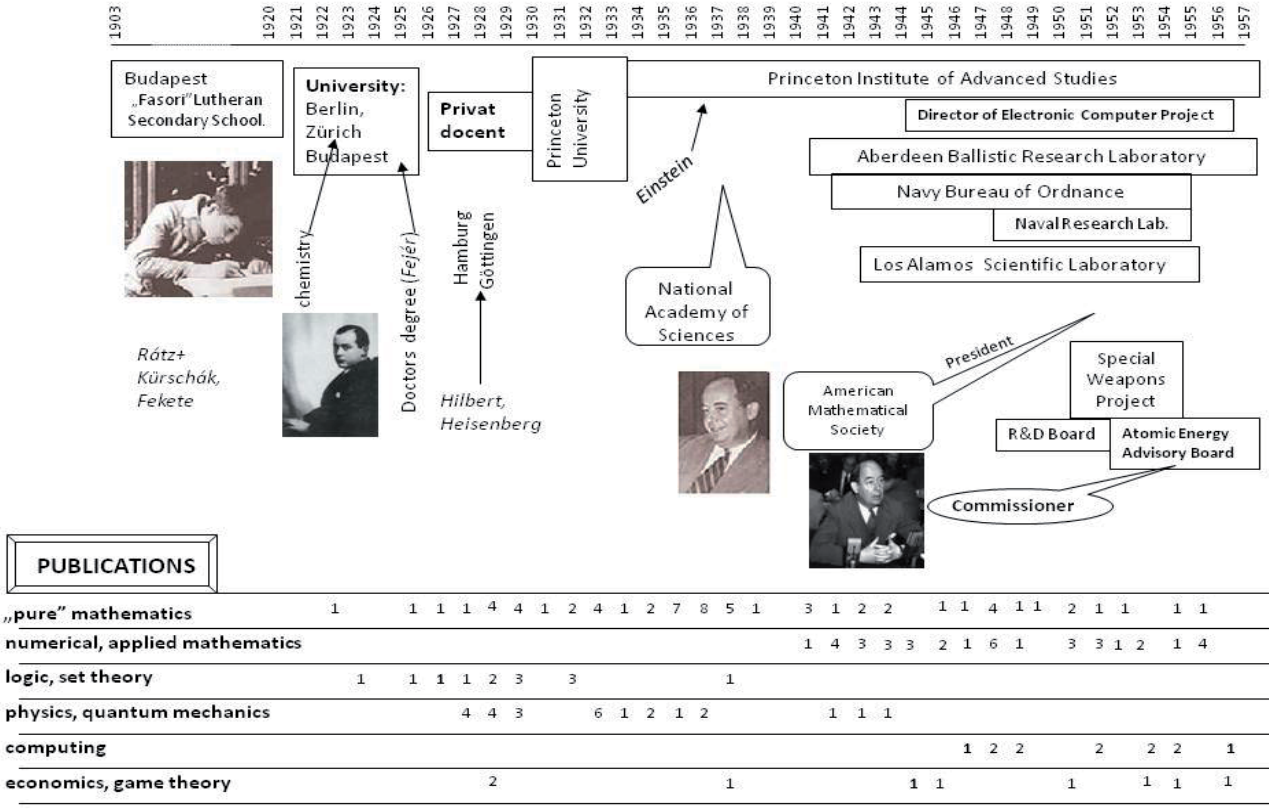
For an overview of John von Neumann's tragically short life see the time-chart below. His 54 years can be divided into three distinct periods.

The first period (pre 1926) can be defined as *learning*. Its defining venue was the legendary "*Fasori" Lutheran Secondary School*. His mathematical talent was very soon recognized by the famous teacher *Laszlo Ratz*, who asked two professors of the Budapest Technical University, *Jozsef Kürschak* and *Mihaly Fekete* to "coach" the schoolboy Neumann. This collaboration resulted in a joint paper published in a well-respected German journal in 1922. University studies were complicated for Neumann by the Hungarian political situation ("numerus clausus") and also because of his father's wish that John should have a profession more "practical" than mathematics. He studied chemistry in Zurich, but at the same time received a doctor's degree in mathematics from *Lipot Fejer* in Budapest (1926).

The second period (1927-1941) is characterized by the activities of the *mature scientist*. The first few years were still spent in Europe, at the universities of Hamburg and later Gottingen, where *David Hilbert* turned his attention to the problems of the foundation of mathematics (logic, set theory). Here he also met *Werner Heisenberg*, this being the source of the significant results of John von Neumann in the mathematical foundations of quantum mechanics.

Europe soon proved to be a too narrow space for the young scientist: he realized that the United States might provide more opportunities for real scientific research. In 1930 he left Europe behind and moved to Princeton University and in 1933 was invited to the Institute of Advanced Study, where he remained a staff member until the end of his life. This Institute was a meeting point of leading scientists of the world, like *Albert Einstein*, *Kurt Gödel* and others. In this environment his scientific activities flourished, obtaining significant results in a wide variety of topics.

His life of leading American mathematician was interrupted by the Second World War. As for the majority of American scientists, winning the war became the most important priority for John von Neumann as well. His daughter wrote[1]: "*...my father led a double life: as a commanding figure in the ivory tower of pure science, and as a man of action, in constant demand as an advisor, consultant and decision-maker in the long struggle to insure that the United States would be triumphant in both the hot and the cold wars that together dominated the half century from 1939 until 1989.*" As you can see on the right hand side of our time-chart, in this third period of his life John von Neumann did participate in the work of several military-related research organizations, including the Manhattan project, and finally be-



came Commissioner in the Atomic Energy Advisory Board of the United States.

In the lower part of the time-chart we can see a brief "statistical" analysis of John von Neumann's scientific activity, based on a rather rudimentary classification of a list of his nearly 200 publications[2]. A few conclusions:

- "pure" mathematics was in the center of von Neumann's interest during his whole life;
- the dominating topics of his "ivory tower" period were logic and set theory as well as physics, mostly quantum mechanics;
- many publications on applied mathematical topics, especially on the problems of collision and shock waves appeared during the war period;
- the post war period is dominated by papers on his new interest: computing, and also by continuing to work on economics topics (mostly game theory).

As can be seen by the number of publications, computing related papers form only a relatively small part of John von Neumann's scientific heritage. Moreover, they belong to the third, "man of action" period of his life, so they are more practical documents, rather than academic type of publications. They show, however, a strong connection between the two sides of his life. Quoting again from his daughter's book: "*These two aspects of his persona, the ivory tower thinker and the man of action, combined to produce the "von Neumann architecture" of the modern stored-program computer. The deep understanding of mathematics, physics, and engineering that characterized his purely intellectual accomplishments provided the necessary brainpower; the commitment to freedom that spurred the man of action provided the motivation."*

We may summarize, that John von Neumann, being one of the greatest mathematicians of the first half of the 20th century, did achieve valuable results in many other scientific disciplines too. His theoretical and practical work in the field of computing resulted in the elaboration of the stored program principle, what can be regarded as the basis of the enormous technological development, leading to what is now called "Information Society".

It might be interesting to ask the question: How would John von Neumann look at our present situation, with the all-pervasive role of "computing" in every aspect of society and economy. There might be two answers to this question:

- the trivial **positive** answer can be that he should be very pleased by the success of his "brain child", resulting in all embracing changes in the life of humanity. Moreover, by refusing to patent the basic ideas of stored program computing, he did actively contribute to the spread of computing technologies all over the world;
- there is also a trivial **negative** answer, considering that John von Neumann regarded the computers only as tools for performing complicated scientific and technical calculations, solving difficult problems in areas like the military, meteorology etc. Using computers for "simpler" tasks was considered by him a waste of the valuable computing power.

  Even within the field of computing he opposed the use of computers to tasks, which can be done by human power (e.g. what is called "software technology" now): the first ideas of assemblers and programming languages like FORTRAN were dismissed by him as useless.[3]

So, it is questionable, how John von Neumann would have liked our PC/Internet/smartphone oriented world, where the overwhelming majority of computing equipment is used for tasks that would be considered by him as "clerical".

In this way John von Neumann could have been regarded as one of those outstanding scientists, who made a really significant discovery at one time but failed to recognize all the consequences of his achievement in the (unforeseeable) future. This is not an uncommon phenomenon in the history of science and should not decrease at all our admiration about the results or the person.

In the case of John von Neumann, however, **this is not the complete truth!** One can start to play around with the idea how the extreme ingenuity of John von Neumann could have found its challenges in the world of modern computing and what significant theoretical and practical results he might have achieved in various areas of design and application of computing devices. But this would be speculation only! What is not speculation, however, is the fact that apart from the "John von Neumann architecture", there are several more ideas and results in Neumann's heritage, finding important applications in present day computing.

Let us see a few examples:

- Our IT world is based on the organized cooperation of different **interconnected devices** providing services to each other (see buzzwords as *cloud*, *web services* etc). The individual quality of each of these devices and services might be completely different. The whole system, however, should work on a higher level of quality as that of its individual components. The theoretical foundation for handling of such situations is given in John von Neumann's work on the building of reliable systems from unreliable components[4], which is often quoted in papers about cooperative systems.

  Java evangelist *Frank Sumners* introduced *Jini*, - one of the "first systems for distributed computing designed with the explicit acknowledgement that each component of a distributed system, including the network, is unreliable", - with a reference to von Neumann's work: "*The trick is to make highly reliable systems out of unreliable components. John von Neumann... was the first to study this problem in the 1940s; in his time, computer parts were notoriously flaky*."[5]

- One of the most spectacular developments in computing in our days is the wide spread use of **3D printing**. This means that results of the work of our computer programs can appear also in the physical world, producing different kinds of objects. A logical continuation of this idea would be to have a printer that could print itself. The theoretical possibility of building such a Universal Constructor was proven by John von Neumann in his (unfinished) work on cellular automata[6]. Practical realizations appear in several projects connected to 3D printing.

  A rather ambitious project of this kind RepRap (*replicating rapid prototype[7]*) was started at the University of Bath (United Kingdom) in 2005 and developed several hundreds of realizations in many countries. Initiator of the project *Adrian Bowyer* writes: *"We are trying to prove the hypothesis: rapid prototyping and direct writing technologies are sufficiently versatile to allow them to be used to make a von Neumann Universal Constructor."*

- Perhaps the most significant impact to present day computer science comes from von Neumann's last work, the unfinished manuscript of the traditional Silliman lectures at Yale University, published after his death[8]. Here ideas about comparing the structure and operation of computers with the (human) brain are analyzed in detail. This topic is now in the center of interest of IT research, with mega projects on both sides of the Atlantic, trying to simulate the operation of the brain[9] or building computers with ideas borrowed from its structure[10]. Using analogous elements in cooperation with digital solutions is part of the present trends[11], following ideas raised by John von Neumann also there.

These few examples may convince us to regard John von Neumann not only an outstanding personality of our **past**, as "father of the stored program principle", but also as a source of significant ideas to be used in **present** computer science research. Moreover, if we consider that Quantum Computing is regarded as the most promising computing paradigm of the **future**, and remember Neumann's fundamental results in quantum mechanics, then maybe we can change the title of this paper to "*John von Neumann: past, present and future"*.

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John von Neumann in Hungary

Neumann János (the original name of John von Neumann) was born and educated in Hungary, but spent all of his adult life elsewhere, mostly in the United States. Hungary, however, is very proud of his achievements and keeps his heritage in the highest esteem.

The professional society of Hungarian computer scientists, founded in 1968, is called *John von Neumann Computer Society*. Several schools, streets etc. also bear his name. The year 2003, when the 100th anniversary of his birth was celebrated, was officially declared by the Hungarian government as "Neumann Year". Several international conferences were devoted to different areas of John von Neumann's scientific activities. The concluding event was the Centennial Congress of the John von Neumann Computer Society, opened by the President of Hungarian Republic and featuring many prominent international speakers, including his daughter Marina von Neumann Whitman.

In 2013 Marina was invited again as honorary guest at the opening of the IT Museum in Szeged[12], which houses a large scale collection of historic computing equipment as well as several unique relics of John von Neumann's life). In her talk[13] at the opening conference she said:

My father's presence was closest in 2003, when Hungary staged a national celebration commemorating the hundredth anniversary of his birth. I was invited to participate as an honored guest, an honor that carried with it one of the most hectic schedules I've ever encountered. A couple of weeks after finishing treatment for breast cancer, I found myself not only giving talks about my father at internationally attended meetings of the Hungarian Mathematical and Computer Science societies in Budapest, but also giving informal talks about him, in English, to students in schools all over Hungary. Thank goodness it's a small country; Bob and I were transported to every corner of it in the cramped elderly vehicle belonging to one of my father's self-appointed promoters[1], who enthusiastically acted as our chauffeur. Some of the schools were actually named after von Neumann, but in all of them students knew who he was, what he had accomplished, and had created various exhibitions to honor him. I tried to imagine American high-school students according a long-dead mathematician the sort of veneration reserved here for sports and entertainment celebrities! ■

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The Viennese New Year's Concerts

Dorothy Hayden

Vienna is world-famous for its New Year's concerts, which are televised and broadcasted live on 1 January with millions of viewers around the world.

The concerts have a long tradition – the 1st was performed on 31 December 1939 in the "Großer Saal" of the Musikverein, and since then all consequent concerts are given on New Year's Day. The performance of the Vienna Philharmonic always includes compositions (waltzes, polkas, mazurkas and marches) from the Strauss family with occasional pieces from other Austrian composers. In recent years, the encores have become a tradition and *The Blue Danube* and the *Radetzky March* are the culmination of this memorable event.

In 1980 Lorin Maazel became the first non-Austrian conductor of the concert and the practice of choosing different star conductors began in 1987 with Herbert von Karajan.

Daniel Barenboim is invited to conduct the 2014 New Year's Concert of the Vienna Philharmonic. This invitation is made in recognition of 25 years of musical collaboration between the Vienna Philharmonic and the General Music Director of the State Opera *Unter den Linden* in Berlin.

There is an extremely high demand for the New Year's Concert and ticket prices range from EUR 30 to EUR 940. Few will be the lucky ones to be in the Musikverein on 1 January 2014 for the concert starting at 11.15 hrs. There is, however, the possibility to view it live along with more than 50 million viewers in some 80 countries around the globe.

The "Großer Saal" of the Musikverein
Source: commons.wikipedia.org ■

Towards a Creative Information Society

Highlights from the 8th International Conference on Knowledge, Information and Creativity Support Systems

Andrzej Skulimowski

Andrzej M.J. Skulimowski is Professor at the AGH University of Science and Technology and Director of the Decision Sciences Laboratory. Since 1995, he is President of the International Progress and Business Foundation, Kraków, Poland and served as General Chair of KICSS'2013.

After seven successful interdisciplinary conferences organized in East Asia and Australia, the 8th International Conference on Knowledge, Information and Creativity Support Systems (KICSS'2013) has been organized for the first time in Europe - in Kraków and Wieliczka, Poland. The previous conferences in this series were held in Ayutthaya, Thailand (2006), Ishikawa, Japan (2007), Hanoi, Vietnam (2008), Seoul, Korea (2009), Chiang Mai, Thailand (2010),